

Impact of Strategic Changes on the Performance of Trucking Firms in the Agricultural Commodity Transportation Market

Albert J. Allen

Department of Agricultural Economics
Mississippi State University
Mississippi State, MS 39762
Email: allen@agecon.msstate.edu

Haiyuan Wang

Department of Industrial Engineering
Mississippi State University
Mississippi State, MS 39762

Safdar Muhammad

Cooperative Agricultural Research Program
Tennessee State University
Nashville, Tennessee 37209-1561

Gerald Mumma

Center for Disease Control and Prevention
Atlanta, Georgia

A.A. Farhad Chowdhury

Department of Business Administration
Mississippi Valley State University

Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting, Alabama, February 1-5, 2003

Copyright 2003 by Albert J. Allen, Haiyuan Wang, Safdar Muhammad, Gerald Mumma, and A.A. Farhad Chowdhury. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

Abstract

Econometric models were developed to estimate factors that influence strategic changes and evaluate the impacts that strategic changes will have on the subsequent performance of agricultural commodity trucking firms. Results reveal that GDP and change in firm size will have positive impacts on strategic changes made by firms.

Introduction

For-hire agricultural commodity trucking firms are constantly forced to act and react in response to changes in their external and internal environments. It is their choice as to what actions to take, if any. Those actions, or choices of inaction, continually have performance implications for stakeholders.

Strategic changes can be defined as those alterations a firm makes in its business approach to better align itself with its environment in its efforts to maintain and/or improve performance. For-hire agricultural commodity trucking firms do have the ability to make strategic changes and do make those changes using a variety of strategic resources, when faced with strong changes in their environments. Agricultural trucking firms do not make all the same changes, do not change at the same time, nor gain the same performance impacts from their actions

This study will enrich our understanding of the links between the external and internal forces that impel an agricultural commodity-trucking firm to alter and adapt its strategic focus over time. This research contributes to the field of strategic management in its time series perspective and its individual firm-level analysis of strategic changes.

Objectives of the Study

The objectives of this study are as follows:

1. To develop firm strategic change indices on an individual firm level over the 1992-1999 period for agricultural commodity trucking firms.
2. To evaluate the external and internal factors that influences an agricultural commodity-trucking firm to change or not change its strategic focus over time.
3. To evaluate the performance implications of an agricultural commodity trucking firm's decision to alter its strategic focus over time.

Data, Methods, and Models

The process of obtaining the objectives of this study is twofold. First, a categorization of carrier decisions into key dimensions is done. Second, a model of strategic change is developed. The key dimensions that best summarize the range of management decisions in the trucking industry for this analysis include Cost, Price, Risk, Service, and Size. For each of these identified dimensions, a key financial and/or operating performance measure was used as representative indicators of management decisions that constitute the essence of strategy. Data for the financial and operating performance measures were obtained from TTS Blue Book of Trucking Companies, published by Technical Transportation Services. Table 1 provides details on how each key dimension was measured.

Table 1: Type of Strategic Change Dimensions and Representative Financial Measures Used for Study

Type of Dimension	Representative Financial Measure
Cost Dimension	Operating Expenses/Miles
Price Dimension	Total Revenues/Total Tons
Risk Dimension	Total Debt/Total Equity
Service Dimension	Total Salary, Wages and Fringe Benefits/Total Number of Employees
Size Dimension	Total Operation Revenues

Source: Feitler et al.

In this study the cost dimension measure captures the spectrum of the agricultural commodity firm's cost including salaries, wages, taxes, and other expenses. The price dimension provides information on prices that the firm charged for its services. The risk dimension captures information on how well the agricultural commodity firm's manager/owner handles its capital resources.

The service dimension captures information on customer services and the employee costs in providing that service for compensation by the firm. The size dimension is used to indicate how the strategic focus of different size firms is affected by actions/inaction by its management.

The individual firm's variable dimension score starts with the general ledger account balance or ratio for each firm in each year. In the beginning, for each year, all agricultural commodity- trucking firms in the data set were used. Those firms with missing data on any single dimension were eliminated for that specific year.

Based on previous studies by Boeker (1989) and Feitler (1995) concerning strategic change, two models of individual firm strategic change were developed. In Model One, a strategic change index was calculated for each firm in each year using the sum of the yearly changes in the absolute values of the above dimensions. Using the base year and then for each year after, the changes in standardized scores on individual dimensions, taken in terms of absolute values, were computed as the strategic change index. The strategic change index was used to provide an indication of how an individual firm changed its position relative to industry averages as well as changes on each individual dimension, and how external and internal factors influenced individual firm strategic changes. The proposed regression Model One is as follows.

$$Y_{it} = \beta_0 + \beta_1 * X_{i1t} + \beta_2 X_{i2t} + \beta_3 * X_{i3t} + \beta_4 * X_{i4t} + \beta_5 * X_{i5t} + \beta_6 * X_{i6t} + \beta_7 * X_{i7t} \\ + \beta_8 * X_{i8t} + \beta_9 * D_{i2t} + \beta_{10} * D_{i3t} + \varepsilon_i$$

Where,

Y_{it} : The i th observation of SCINDEX from year t to year $t+1$

β_0 : Intercept

β_k : Coefficients for independent variables. $k=1, 2, 3 \dots 9, 10$.

X_{ijt} : The i th observation of j th independent variable related to year t . $i=1,2,3 \dots 194,195$

in the model, $j=1,2,3 \dots 7,8$ in the model.

X_{i1t} : The i th observation of LN ($|CFIRMSIZE|$) from year t to year $t+1$

X_{i2t} : The i th observation of LN (SIZE) for year t

X_{i3t} : The i th observation of PREY-ORS for year $t-1$

X_{i4t} : The i th observation of PIRATES for year t

X_{i5t} : The i th observation of CPI for year t

X_{i6t} : The i th observation of AAUR for year t

X_{i7t} : The i th observation of DFUELPRS for year t

X_{i8t} : The i th observation of GDP for year t

D_{i2t} : The i th observation of LAW1. $D_{i2t}=1$, if the year is 1995, 0 otherwise

D_{i3t} : The i th observation of LAW2. $D_{i3t}=1$, if the year is 1998, 0 otherwise

t : The years 1992...1998,1999.

The dependent variable SCINDEX in Model One is the year-to-year change in the strategic change index and independent variables are internal and external factors.

Internal factors affecting a firm's strategic change for this study consist of size of the firm, prior performance, and change in size of firm.

According to Feitler (1995), firm size is associated with resistance to change. As the size of the firm increases, firm behavior becomes more predictable and controlled as it becomes more formalized. As a result, the likelihood of change in strategic focus declines as firm size increases. Thus, it is expected that the size of the firm will have a negative impact on strategic change. In this study the variable is measured by $\ln(\text{Total Operating Revenues})$ due to the large values of this variable. This independent variable is represented in Model One by $\text{LN}(\text{SIZE})$.

The change in the size of the firm is expected to have a positive impact on strategic change. For example, if a firm is merged with another firm, strategic changes will likely come about. In this study, the change in firm size is measured by $\ln(|\text{Revenue}_{t+1} - \text{Revenue}_t|)$. This independent variable is represented in Model One by $\text{LN}(|\text{CFIRMSIZE}|)$. Performance for each firm is measured by each firm's Operating Ratio ($\text{Total Operating Expenses} / \text{Total Operating Revenues}$). Therefore, prior performance for each firm was measured by the previous year's operating ratio figures for each firm. This independent variable is represented in Model One by PREY-ORS .

External factors include environmental change and legislative change. The environmental factors include gross domestic product, diesel fuel prices, prime interest rates, unemployment rates, and consumer price index. Legislative changes include various federal trucking laws that have been passed during the study period. The trucking laws selected for this analysis include the National Highway System Designation Act of 1995 (November 28, 1995), and the Transportation Equity Act for the

21st Century, TEA-21 (June 9, 1998). They are represented in Model One by LAW1 and LAW2.

The environmental factors were considered to have some impact on strategic changes. Federal legislation at the national level is expected to have a positive impact on strategic changes. The external factors are represented by AAUR, CPI, PIRATES DFUELPRS, and GDP in the model. They were obtained electronically from the following secondary sources.

The average annual unemployment rates (AAUR) for the U.S. were obtained from the Oregon Employment Department website. The consumer price index values (CPI) for this analysis were obtained from the U.S. Department of Labor, Bureau of Labor Statistics, Washington, D.C. website. Diesel fuel prices (DFUELPRS) were obtained from National Transportation Statistics 2001, Bureau of Transportation Statistics, Washington D.C. website. Gross domestic product (GDP) values for the U.S. were obtained from the Bureau of Economic Analysis website. Prime interest rates (PIRATES) were obtained from the Federal Reserve Bank of New York website. Information on federal legislation affecting the trucking industry was obtained from the Federal Highway Administration, U.S. Department of Transportation website. The website addresses for all of the electronically sources used for the external factors are found in the References.

Model Two investigates the impact of strategic change on a firm's subsequent performance. Strategic change is expected to have a positive impact on a firm's subsequent performance. In this model, the firm's strategic change index is used as an indicator of strategic change. Performance is measured as the Operating Ratio $t+2$,

measuring performance in the year subsequent to strategic changes. Thus, this model looks at strategic change in year one and performance impacts in the following year. The proposed regression Model Two is as follows.

$$Y_{it} = \beta_0 + \beta_1 * X_{i1t} + \beta_2 D_{i2t} + \beta_3 * D_{i3t} + \beta_4 * D_{i4t} + \beta_5 * D_{i5t} + \beta_6 * D_{i6t} + \beta_7 * D_{i7t} + \beta_8 * D_{i8t} + \beta_9 * D_{i9t} + \beta_{10} * D_{i10t} + \varepsilon_i$$

Where,

Y_{it} : The i th observation of POSTOR for year $t+2$

β_0 : Intercept

β_k : Coefficients for independent variables. $k=1, 2, 3 \dots 9, 10$

X_{ijt} : The i th observation of j th independent variable related to year t . $i=1, 2, 3 \dots 116, 117$

in the model, $j=1$ in the model

X_{i1t} : The i th observation of SCINDEX from year t to $t+1$

D_{ijt} : The i th observation of j th independent variable related to year t . $i=1, 2, 3 \dots 116, 117$ in

the model, $j=2 \dots 9, 10$ in the model

D_{i2t} : The i th observation of INDEX2. $D_{i2t}=1$, if firm's strategic change index is in the range of 0.51-1.01, 0 otherwise

D_{i3t} : The i th observation of INDEX3. $D_{i3t}=1$, if firm's strategic change index is in the range of 1.02-1.52, 0 otherwise

D_{i4t} : The i th observation of INDEX4. $D_{i4t}=1$, if firm's strategic change index is in the range of 1.53-2.03, 0 otherwise

D_{i5t} : The i th observation of INDEX5. $D_{i5t}=1$, if firm's strategic change index is 2.04 or greater, 0 otherwise

D_{i6t} : The i th observation of the year t . $D_{i6t}=1$, if the year is 1994, 0 otherwise

D_{i7t} : The i th observation of the year t . $D_{i7t}=1$, if the year is 1995, 0 otherwise

D_{i8t} : The i th observation of the year t . $D_{i8t}=1$, if the year is 1996, 0 otherwise

D_{i9t} : The i th observation of the year t . $D_{i9t}=1$, if the year is 1997, 0 otherwise

D_{i10t} : The i th observation of 1998 the year t . $D_{i10t}=1$, if the year is 1998, 0 otherwise

t : The years 1992...1998, 1999.

In Model Two, Operating Ratio $t+2$ is the dependent variable. The dependent variable is represented by POSTOR in the model. The independent variables are the strategic change index (SCINDEX). Different firm distribution categories were set up based on the breakdown of the strategic change index using five dummy variables. This categorization allowed for a closer analysis of individual firm strategic changes. Also included in this model were dummy variables for each year (1994-1998) to control the effects of a time trend and performance trends over time.

The regression models were run in the STATISTICA package using standard regression method. After running the econometric models using standard method, the authors found that the models can be improved by using forward stepwise variable selection method. According to Rawlings et al, the forward stepwise variable selection method chooses the subset models by adding one variable at a time to the previously chosen subset. The variable in the subset of variables not already in the model that causes the largest decrease in the residual sum of squares is added to the subset. Information on results and analyses of original models can be found in appendix. Therefore, the results of revised models are presented in this paper.

Results

The model selection procedure resulted in variables LN ($|CFIRMSIZE|$), LN (SIZE), PREY-ORS, PIRATES, GDP and LAW2 being selected. The improved model is as follows.

$$Y_{it} = \beta_0 + \beta_1 * X_{i1t} + \beta_2 X_{i2t} + \beta_3 * X_{i3t} + \beta_4 * X_{i4t} + \beta_8 * X_{i8t} + \beta_{10} * D_{i3t} + \varepsilon_i$$

Where,

All the parameters denote the same meaning as mentioned above.

Regression result summary for the improved model is in table 2.

Table 2: Model One regression summary

N=195	Regression summary for Dependent Variable: Y_{it} - SCINDEX R=0.44102994, $R^2=0.19450741$, Adjusted $R^2=0.16880020$ F (6,188)=47.5663, P <0.0000, Standard Error of Estimate: 1.4871			
Variable	Parameter Estimates	Standard Errors	t -statistic	p-value
Intercept	-5.37779	3.501913	-1.53567	0.126300
LN ($ CFIRMSIZE $)*	0.30207	0.084210	3.58711	0.000426
LN (SIZE)	0.29055	0.206426	1.40755	0.160916
PREY-ORS	-0.02172	0.020469	-1.06133	0.289899
GDP *	0.00142	0.000431	3.30149	0.001151
PIRATES *	-0.66460	0.206621	-3.21651	0.001528
LAW2**	-1.09540	0.492615	-2.22364	0.027364

* Significant at $\alpha = 0.01$

** Significant at $\alpha = 0.05$

The results show that if there is one unit increase of firm size, it will result in 0.30207 unit improvement of strategic change index. Also if there is one unit increase of prime interest rate, it will result in 0.66460 units decline of strategic change index. This implies that these firms over this time period may not have expanded the operations because of the additional cost resulted by the increase of interest rate.

The results also show that as the law was enacted in 1998, it resulted in 1.09540 units decline of strategic change index. Although a negative value of the coefficient of LAW2 was not expected, this could imply that the intermodal transportation act may have had an adverse influence on strategic decisions made by those agricultural firms during that time period. The coefficient of variable GDP is positive as expected. This implies that the increase in GDP by one unit will result favorable impact on strategic index change of the firm by 0.00142 units.

As before, the model results also turns out that F test shows that the regression model is overall significant with F value=7.566259 and p=0.00000 (when $\alpha = 0.01$, $\alpha = 0.05$ or $\alpha = 0.10$). The ANOVA table of the analysis is in table 3.

Table 3: Model One ANOVA table

ANOVA table for dependent variable: Y_{it} - SCINDEX					
Source	Sums of Squares	df	Mean Square	F	P-Value
Regression	100.3967	6	16.73278	7.566259	0.000000
Residual	415.7620	188	2.21150		
Total	516.1587				

Based on the forward variable selection procedure, the variables selected were SCINDEX, INDEX4, INDEX5, 1995, 1996, and 1998 for Model Two. The regression model is in equation as follows.

$$Y_{it} = \beta_0 + \beta_1 * X_{it} + \beta_4 * D_{i4t} + \beta_5 * D_{i5t} + \beta_7 * D_{i7t} + \beta_8 * D_{i8t} + \beta_{10} * D_{i10t} + \varepsilon_i$$

Where,

All the parameters denote the same meaning as mentioned above.

Regression result summary for the improved model is in table 4. The results indicate that one unit increase of strategic index change resulted in 1.45549 unit decrease of the post-operating ratio as desired. This means that the strategic changes made by the firms in previous time period has a positive effect on the subsequent performance of the firms.

The results also show that one unit change of time variable 1996 resulted in 2.56456 unit increase of POSTOR and one unit change of INDEX 4 category resulted in 2.91331 unit of increase of POSTOR. The means that the time variable 1996 and the INDEX4 category had a negative impact on the performance of the trucking firms during the study period.

Table 4: Model Two regression summary

N=117	Regression summary for Dependent Variable: Y_{it} - POSTOR R=0.38885489, $R^2=0.15120813$, Adjusted $R^2=0.10491039$ F (6,100)=3.2660, P <0.00540, Standard Error of Estimate: 5.1389			
Variable	Parameter Estimates	Standard Errors	t -statistic	p-value
Intercept	99.20814	0.982611	100.9638	0.000000
SCINDEX*	-1.45549	0.536603	-2.7124	0.007754
1996**	2.56456	1.336472	1.9189	0.07588
INDEX4**	2.91331	1.497979	1.9448	0.054349
1995	1.46226	1.448312	1.0096	0.314890
INDEX5	2.23127	1.680440	1.3278	0.186997
1998	-1.313314	1.291789	-1.0165	0.311609

* Significant at $\alpha = 0.01$

** Significant at $\alpha = 0.10$

As before, the model results also turn out that F test shows that the regression model is overall significant with F value=3.265994 and p=0.005404 (when $\alpha = 0.01$, $\alpha = 0.05$ or $\alpha = 0.10$). This shows great improvement of the original model. The ANOVA table of the analysis is in table 5.

Table 5: Model Two ANOVA table

ANOVA table for dependent variable: Y_{it} - POSTOR					
Source	Sums of Squares	df	Mean Square	F	P-Value
Regression	517.504	6	86.25073	3.265994	0.005404
Residual	2904.960	110	26.40873		
Total	3422.464				

Summary and Conclusions

One of the objectives of this study was to evaluate the impact of internal and external factors on strategic changes made by agricultural commodity trucking firms over the 1992-1999 study period. Another objective was to measure the influence that strategic changes will have on the performance of agricultural commodity trucking firms in subsequent years. Two econometric models accomplished the objectives of this study.

The results in Model One show that GDP and change in firm size will have positive impacts on strategic changes made by firms. Results also show that the prime interest rate and LAW2 have negative impacts on strategic changes made by firms. The results in Model Two show that SCINDEX has a positive impact on post operating ratios of the firms. Results also show that time variable 19996 and the INDEX4 category had a negative impact on the performance of the trucking firms during the study period.

References

- Boeker, W., "Strategic Change: The Effects of Founding and History." *Academy of Management Journal* Vol.32/No.3 (1989):489-513.
- Bureau of Economic Analysis, National Income and Product Accounts Tables. Internet site <http://www.bea.gov/bea/dn/nipaweb/TableViewFixed.asp> (Accessed November 2002)
- Feitler, J. N. "Measuring Firm Strategic Change in the Regulated and Deregulated Motor Carrier Industry: An Eighteen-Year Evaluation." Ph.D. Dissertation, The University of Maryland, 1995.
- Feitler, J.N., T. M. Corsi and C. M. Grimm. "Strategic and Performance Canges Among LTL Motor Carriers: 1976-1993." *Transportation Journal* Vol.37/No. 4 (Summer 1998): 5-12.
- National Transportation Statistics 2001. Internet site http://www.bts.gov/Publications/NTS/Excel/Table_03_08.xls (Accessed November 2002)
- Rawlings, J.O., S. G. Pantula and D.A. Dickey. "Applied Regression Analysis." 1998 Springer-Verlag New York, Inc.
- State of Oregon, Oregon Employment Department, Annual Average Unemployment Rates. Internet site: <http://olms.emp.state.or.us/Pubs/single/annualrates.pdf> (Accessed November 2002)
- STATISTICA and StatSoft, 2300 E. 14th St. Tulsa, OK 74104, USA.
- TTS Blue Book of Trucking Companies, Transportation Technical Services, Inc., New York, 1992-1999 years.
- U.S. Department of Labor, Bureau of Labor Statistics. Internet site <ftp://ftp.bls.gov/Pub/special.request/CPI/CPIAI.txt> (Accessed November 2002)
- U.S. Department of Transportation, Federal Highway Administration, Legislation and Regulations. Internet site <http://www.fhwa.dot.gov/legsregs/legislat.html> (Accessed November 2002)

Appendix

Table 1: Original Model One regression summary

N=195	Regression summary for Dependent Variable: Y_{it} - SCINDEX R=0.44976181, $R^2=0.20228568$, Adjusted $R^2=0.15893164$ F (10,184)=4.6659, P <0.00001, Standard Error of Estimate: 1.4959			
Variable	Parameter Estimates	Standard Errors	t -statistic	p-value
Intercept	-86.9659	103.7908	-0.83790	0.403176
LN ($ CFIRMSIZE $)*	0.2885	0.0806	3.35569	0.000962
LN (SIZE)	0.2957	0.2081	1.42064	0.157114
PREY-ORS	-0.0221	0.0207	-1.06522	0.288173
PIRATES**	-0.8106	0.3254	-2.49108	0.013621
CPI	0.8368	0.9042	0.92546	0.355940
AAUR	1.8836	3.2151	0.58586	0.558686
DFUELPRS	-0.1491	0.1565	-0.95261	0.342037
GDP	-0.0049	0.0060	-0.81417	0.416600
LAW1	0.4359	1.0791	0.40393	0.686732
LAW2	0.6048	2.2353	0.27056	0.787031

* Significant at $\alpha = 0.01$

** Significant at $\alpha = 0.05$

Table 2: Original Model One ANOVA table

	ANOVA table for dependent variable: Y_{it} - SCINDEX				
Source	Sums of Squares	DF	Mean Square	F	P-Value
Regression	104.4115	10	10.44115	4.665902	0.000006
Residual	411.7470	184	2.23776		
Total	516.1587				

Table 3: Original Model Two regression summary

N=117	Regression summary for Dependent Variable: Y_{it} - POSTOR $R=0.39776744$, $R^2=0.15821894$, Adjusted $R^2=0.07880563$ $F(10,106)=1.9923$, $P < 0.04116$, Standard Error of Estimate: 5.2133			
Variable	Parameter Estimates	Standard Errors	t -statistic	p-value
Intercept	98.52158	2.875715	34.25986	0.000000
SCINDEX*	-1.55232	0.560150	-2.77125	0.006596
INDEX2	0.39234	2.380722	0.16480	0.869416
INDEX3	1.55954	2.360199	0.66077	0.510195
INDEX4	3.98297	2.536545	1.57024	0.119341
INDEX5	3.45197	2.747914	1.25622	0.211799
1994	-0.43530	2.097881	-0.20749	0.836022
1995	1.27675	2.167914	0.58893	0.557160
1996	2.19705	2.143045	1.02520	0.307604
1997	0.32744	2.123943	0.15417	0.877772
1998	-1.63833	2.095006	-0.78202	0.435948

* Significant at $\alpha = 0.01$

Table 4: Original Model Two ANOVA table

	ANOVA table for dependent variable: Y_{it} - POSTOR				
Source	Sums of Squares	DF	Mean Square	F	P-Value
Regression	541.499	10	54.14987	1.992348	0.041164
Residual	2880.966	106	27.17892		
Total	3442.464				